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OF NEPHROLOGY & TRANSPLANTATION



RRT for critically ill patients with COVID-19 associated AKI: Update

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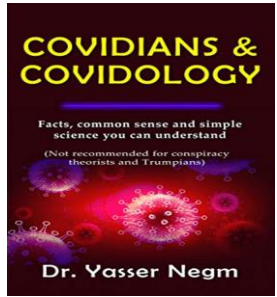
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I have **NO** financial disclosure or conflicts of interest with the presented material in this presentation

AGENDA

- Introduction & Epidemiology
- Pathophysiology of AKI in COVID-19 & potential risk factors
- General outlines of clinical management
- **RRT & extracorporeal support for AKI in COVID-19 Patients**
- **Extracorporeal blood purification therapies for cytokines removal**
- **Summary of international recommendations & guidelines concerning RRT in critically ill patients with Covid-19**
- The precautions that should be adopted by HCPs conducting dialysis treatment to critically ill pts with COVID-19
- Further research
- Conclusion

Introduction

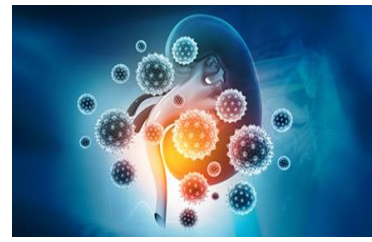


- As the global outbreak of Covid-19, is rapidly evolving & expanding, its full spectrum of effects is becoming evident—from mild, self-limiting respiratory tract illness to severe ARDS, MOF, & death.
- AKI is common among critically ill pts with COVID-19, affecting ~20–40% of pts admitted to ICU & it is considered a marker of disease severity & a negative prognostic factor for survival
- The overall burden of AKI in COVID-19 might be underestimated, as Cr values at admission might not reflect true preadmission baseline kidney function, & previous s Cr values might not be readily available.

Lancet. 2020; **395**: 1054-1062

Kidney Int. 2020; **97**: 829-838

Introduction

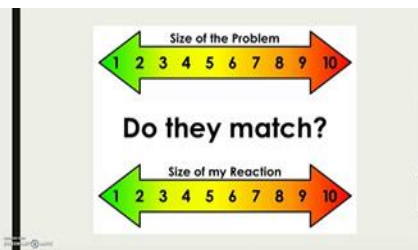


- ~ 20% of pts admitted to an ICU with COVID-19 require RRT at a median of 15 days.
- Early recognition of kidney involvement & use of preventive & therapeutic measures to limit subsequent AKI or progression to more severe stages are crucial to ↓ morbidity & mortality.
- **In this presentation**, we shall focus on discussion of current management of AKI & potential indications for use of RRT & sequential extracorporeal Rxs, including the practicalities of their delivery.
- We also suggest an agenda for future research to obtain adequate evidence to support clinical approaches.

Samaan et al., PLOS ONE | January 14, 2022

Ronco C et al., www.thelancet.com/respiratory, P738-742, 2020

Epidemiology



Data from the literatures demonstrated an AKI incidence of 61-76% in the ICU, with 26-45% of pts in the ICU with COVID-19 needed KRT.
 (Chan L, et al, medRxiv. 2020) (Mohamed M, et al., Kidney360. 2020;1(7):614-622) (Samaan et al., PLOS ONE | January 14, 2022)

AKI Treated with Renal Replacement Therapy in Critically Ill Patients with COVID-19

JASN
JOURNAL OF THE AMERICAN SOCIETY OF NEPHROLOGY

METHODS

- Multicenter cohort study
- N = 3099 critically ill adults with COVID-19
- ICU
- Data from 67 hospitals across the United States
- Logistic regression to identify risk factors for AKI-RRT

OUTCOME

- 21% of patients developed AKI-RRT
- 63% of AKI-RRT patients died in the hospital
- 34% of survivors remained RRT-dependent on discharge

Risk Factors for AKI-RRT

Variable	Odds Ratio (95%CI)
Male	1.2
Non-white Race	1.5
Hypertension	1.3
Diabetes Mellitus	1.4
BMI (kg/m ²)	
<25 (REF)	1.0
25-29.9	1.1
30-34.9	1.2
35-39.9	1.3
≥40	1.4
CKD	
No CKD (REF)	1.0
CKD III	1.5
CKD IV & V	2.5
PaO ₂ :FiO ₂	
Not intubated (REF)	1.0
PaO ₂ :FiO ₂ ≥200	1.1
PaO ₂ :FiO ₂ 100-199	1.2
PaO ₂ :FiO ₂ <100	1.3
D-dimer (ng/ml)	
<1000 (REF)	1.0
1000-2500	1.1
>2500	1.2

Conclusion
 AKI-RRT is common in critically ill patients with COVID-19 and is associated with high inpatient mortality and persistent RRT dependence among survivors.

doi: 10.1681/ASN.2020060897

Acute kidney injury (AKI) in patients hospitalized with COVID-19

Methods & Cohort

- Retrospective cohort
- 13 hospitals in New York
- SARS-CoV-2 positive
- N = 5449
- Age = 64 (52, 75)
- March 1 – April 5, 2020

Results

All AKI
1,993 (37%)

Stage	Percentage
Stage 1	47%
Stage 2	22%
Stage 3	31%

Independent risk factors for AKI

- Older age
- Black race
- Hypertension
- Diabetes mellitus
- Cardiovascular disease
- Vasopressor use
- Need for ventilation*

*OR=10.7 (95%CI 6.8 -16.7)

Disposition of patients with AKI

- Still admitted: 780 (39%)
- Discharged: 519 (26%)
- Died: 694 (35%)

Probability density function vs Time of AKI diagnosis relative to initiation of mechanical ventilation (Days)

CONCLUSION:
 AKI occurs frequently among patients with COVID-19. It occurs early and in temporal association with respiratory failure. AKI in COVID-19 is associated with a poor prognosis.

Hirsch et al, 2020

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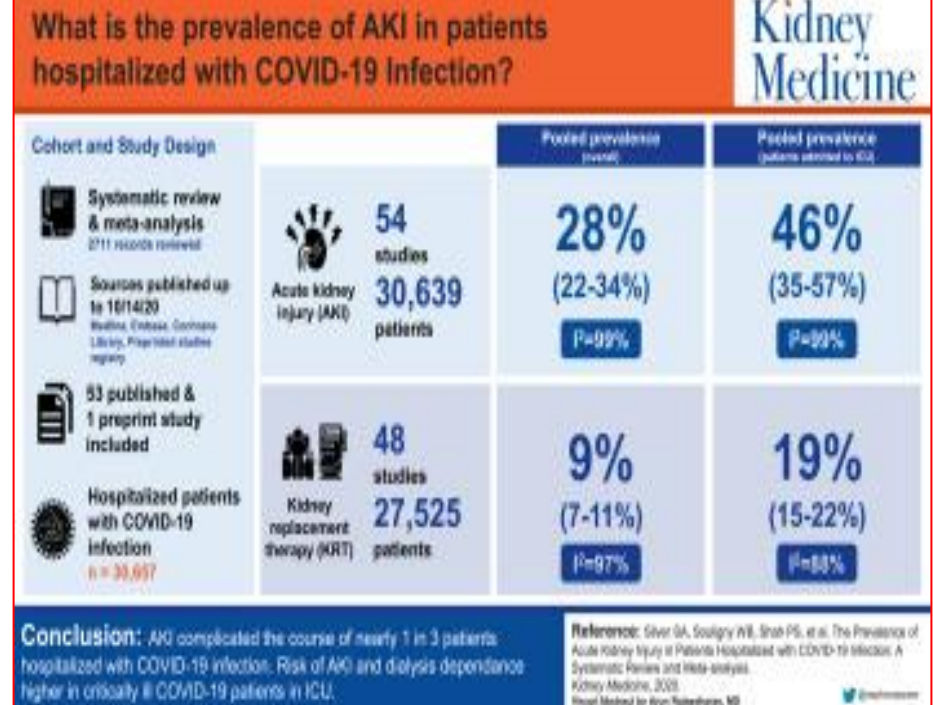
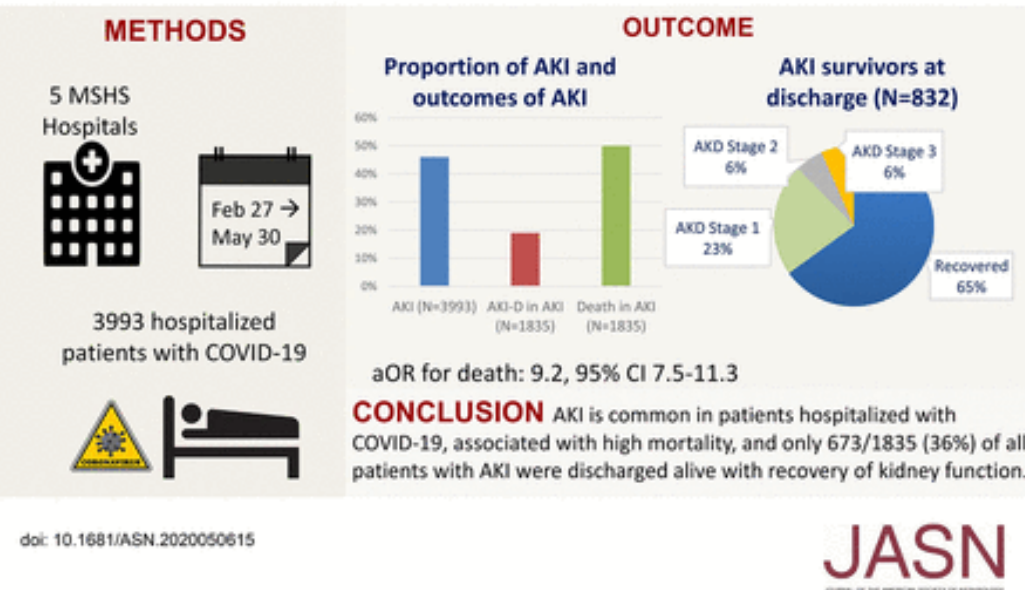
Epidemiology

Significance Statement

Among pts who were discharged, 35% had **not** recovered to baseline kidney function at the time of discharge. AKI is common among pts with COVID-19 and is associated with higher mortality than in pts without AKI; **among those who survive, only about a third are discharged with renal recovery.** These findings may help centers with resource planning & preparing for the increased load resulting from survivors of COVID-19–associated AKI who do **not** experience recovery of kidney function.

JASN Vol. 32, Issue 1 January 2021

Acute Kidney Injury in Hospitalized Patients with COVID-19



Pathophysiology of AKI in COVID-19 ([figure 1](#))

- The cause of kidney involvement in COVID-19 is multifactorial, with CV comorbidity & predisposing factors (eg, sepsis, hypovolemia, & **nephrotoxins**) as important contributors.
- Cardio renal syndrome, particularly RVF secondary to COVID-19 pneumonia, might lead to kidney congestion & subsequent AKI. Similarly, LVD → low COP & kidney hypo perfusion.
- SARS-CoV-2 can directly infect the renal tubular epithelium & podocytes through an ACE2-dependent pathway & cause mitochondrial dysfunction, ATN, the formation of protein reabsorption vacuoles, collapsing glomerulopathy, & protein leakage in Bowman's capsule

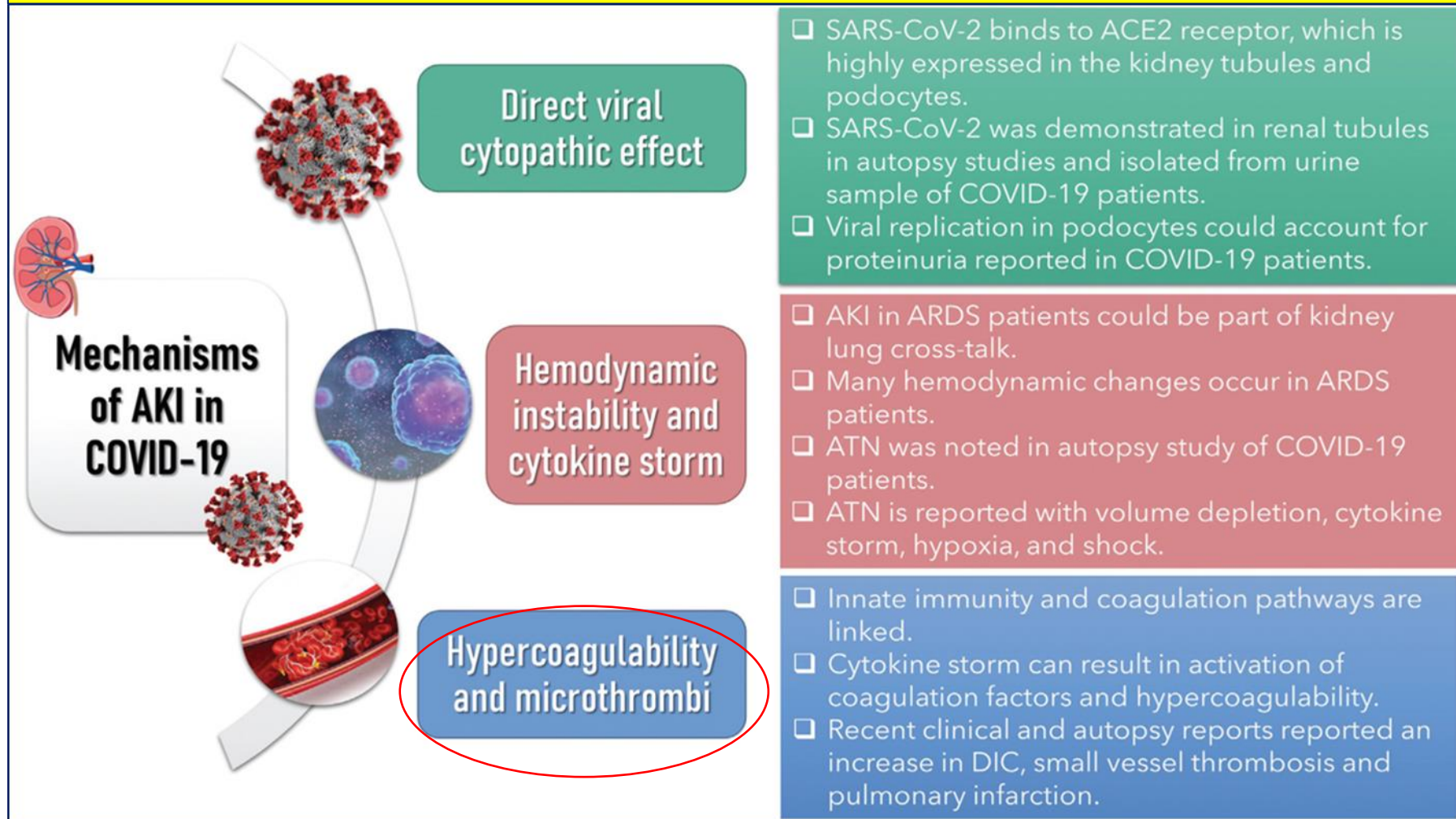


Abdalbary M, Sheashaa H, J ESNT, 2020;20:204-10.

Varga Z, et al. *Lancet*. 2020;395:1417–1418.

Su H, et al. *Kidney Int*. 2020 KI.2020.04.003

Pathophysiology of AKI in COVID-19



Mechanisms of AKI in COVID-19-infected pts. It explains the possible mechanisms of AKI in COVID-19-infected pts and the current evidence supporting each one of them. AKI in COVID-19-infected pts is likely to be multifactorial.

Box 1 | Potential Risk Factors for COVID-19 AKI

Demographic risk factors

- Older age
- Diabetes mellitus
- Hypertension
- Cardiovascular disease or congestive heart failure
- High body mass index
- Chronic kidney disease
- Genetic risk factors (e.g. *APOL1* genotype; *ACE2* polymorphisms)
- Immunosuppressed state
- Smoking history

Risk factors for AKI at admission

- Severity of COVID-19
- Degree of viraemia
- Respiratory status
- Non-respiratory organ involvement, e.g. diarrhoea
- Leukocytosis

- Lymphopaenia
- Elevated markers of inflammation, e.g. ferritin, C-reactive protein, D-dimers
- Hypovolaemia/Dehydration
- Rhabdomyolysis
- Medication exposure, e.g. angiotensin-converting-enzyme (ACE) inhibitors and/or angiotensin-receptor blockers (ARBs), statins, nonsteroidal anti-inflammatory drugs (NSAIDs)

Risk factors for AKI during hospitalization

- Nephrotoxins (medications, contrast exposure)
- Vasopressors
- Ventilation, high positive end-expiratory pressure
- Fluid dynamics (fluid overload or hypovolaemia)



A - General outlines of clinical management



Hussein Sheashaa

- General management of those pts consists of ensuring suitable infection control, supportive care, & possible use of drugs with potential activity against (SARS-CoV-2).
- Management plans should include pharmacologic prophylaxis of VTE for all hospitalized pts.
- The critically ill COVID-19 +ve pts should be treated in isolation ICUs dedicated to COVID-19.

Shemies RS, et al., Ther Apher Dial. 2021;1-9.

Clinical management of AKI

- Implementation of the KDIGO supportive care guideline (eg, avoidance of nephrotoxins, regular monitoring of S Cr & UOP , hemodynamic monitoring) in critically ill pts with kidney involvement.
- Mitigation of volutrauma & barotrauma through the application of lung-protective ventilation & a relatively low PEEP strategies lowers the risk of new or worsening AKI.
- Adjust fluid balance according to volume responsiveness & tolerance assessment → ↓ the risk of pulmonary edema, RV overload, congestion, & subsequent AKI.
- Volume depletion at admission might be common in pts with COVID-19, (b/o fever). In these cases, hypovolemia should be corrected to prevent AKI.

Potential management strategies of AKI

Table 2 | Potential management strategies for COVID-19 AKI

Therapy	Rationale	Recommendation
Standard measures		
Standard measures based on AKI risk and stage	Prevention and management depend on the risk and stage of AKI	Strategies based on KDIGO and other relevant guidelines are appropriate for risk- and stage-based prevention and management of COVID-19 AKI (ungraded)
Measurement of kidney function	The measurement of kidney function is necessary for precise clinical assessment of risk and stage of AKI. Serum creatinine and urine output are the current gold standards for the evaluation of kidney function, although neither is kidney specific or sensitive for detection of early kidney injury	We recommend monitoring kidney function using a minimum serum creatinine and urine output with careful consideration of the limitations of both (evidence level: 1B)
Haemodynamic optimization	Hypovolaemia, hypotension, and vasoplegia may occur in patients with COVID-19. Fluid and vasopressor resuscitation using dynamic assessment of cardiovascular status may reduce the risk of renal injury and respiratory failure	We recommend individualized fluid and haemodynamic management based on dynamic assessment of cardiovascular status (evidence level: 1B)
Fluid management	The composition of crystalloids for volume expansion is important. Individual trials in non-COVID patients have shown reduced risk of AKI with use of balanced fluids for initial volume expansion, especially in sepsis	We recommend using balanced crystalloids as initial management for expansion of intravascular volume in patients at risk of or with COVID-19 AKI unless an indication for other fluids exists (evidence level: 1A)
Glucose management	Insulin resistance and a hypercatabolic state are common in COVID-19 and contribute to hyperglycaemia	We suggest monitoring for hyperglycaemia and use of intensive glucose-lowering strategies in high-risk patients (evidence level: 2C)
Nephrotoxin management	Nephrotoxins are frequently prescribed in patients with COVID-19. The risks and benefits of these medications and their alternatives need to be closely and frequently assessed. This includes assessment of NSAID use	We recommend limiting nephrotoxic drug exposure where possible and with careful monitoring when nephrotoxins are required (evidence level: 1B)
Use of contrast media	Some studies have challenged the relevance of contrast media toxicity in critically ill patients; furthermore, sodium bicarbonate and N-acetylcysteine have not been shown to prevent contrast-media-associated AKI	We recommend optimization of intravascular volume status as the only specific intervention to prevent contrast-media-associated AKI (evidence level: 1A)

Experimental strategies		
Antivirals	Some evidence suggests that direct viral infiltration of tubular cells and podocytes has an impact on tubule function and glomerular filtration	Evidence that antivirals may reduce the risk of COVID-19 AKI is indirect and limited
Immunomodulatory agents (e.g. hydroxychloroquine, corticosteroids, tocilizumab, sarilumab, anakinra, imatinib, dasatinib, ciclosporin, immunoglobulins, baricitinib)	SARS-CoV-2 infection can induce the release of IL-1, IL-6, TNF and other cytokines, as well as secondary HLH. Immunomodulatory agents have the potential to attenuate cytokine production or block cytokine-receptor activation and inhibit autophagy and lysosomal activity to modulate inflammation in host cells	Existing data on immunomodulation in COVID-19 do not show an impact on the development or progression of AKI
Systemic anticoagulation	Thrombi in the renal microcirculation may contribute to the development of AKI	No data are available to show that anticoagulation strategies reduce the risk of AKI or mitigate AKI progression. Systemic anticoagulation may be needed to maintain filter patency during RRT
Statins	Statins inhibit the production of pro-inflammatory cytokines (e.g. TNF, IL-10, IL-6 and IL-8) and the activation and proliferation of T cells, potentially leading to immunomodulation	No data are available to show that statins reduce the risk of AKI or mitigate progression
ACE-I and/or ARBs	ACE-I and ARBs increase ACE2 levels and may rescue cellular ACE2 activity	The impact of RAAS inhibitors on the development or prevention of COVID-19 AKI is uncertain
NSAIDs	Anti-inflammatory properties	Effect unknown
Recombinant ACE2	Potential to neutralize the SARS-CoV-2 and rescue cellular ACE2 activity	Under investigation
Serine inhibitors	Blockage of transmembrane protease serine 2 activity and prevention of viral infiltration	Under investigation

ACE, angiotensin-converting-enzyme inhibitor; ACE2, angiotensin converting enzyme 2; AKI, acute kidney injury; ARB, angiotensin-receptor binder; HLH, haemophagocytic lymphohistiocytosis; JAK, Janus kinase; KDIGO, Kidney Disease: Improving Global Outcomes; RAAS, renin-angiotensin-aldosterone system; RRT, renal replacement therapy.

Stage-based management of COVID-19 AKI.

High risk	AKI stage 1	AKI stage 2	AKI stage 3
Standard of care to prevent and manage multiorgan failure			
Individualize fluid management, avoid saline unless specific indication			
Consider dynamic haemodynamic monitoring			
Monitor serum creatinine and urine output			
Correct hypoglycaemia			
Consider alternatives to radiocontrast if possible without delaying urgent imaging			
Avoid nephrotoxic agents when possible			
Consider AKI risk in selecting ventilator strategies			
Diagnostic workup			
Consider altered pharmacokinetics			
Consider renal replacement therapy			
Avoid subclavian access			
<p>Direct viral effect: Coronavirus kidney infection</p>	<p>Indirect effects:</p> <ul style="list-style-type: none"> • Hypervolaemia • Injury to the lungs • Systemic inflammation 	<ul style="list-style-type: none"> • Superinfection • Rhabdomyolysis • Formation of thrombi 	<p>Clinical management effects:</p> <ul style="list-style-type: none"> • Nephrotoxins • Hypervolaemia • Lung–kidney crosstalk

The pathogenesis of acute kidney injury (AKI) in pts with COVID-19 (COVID-19 AKI) likely involves direct viral effects, indirect effects and sequelae from disease management. There is no specific evidence to suggest that COVID-19 AKI should be managed differently from other causes of AKI in critically ill pts; however, the possible underlying disease mechanisms should be taken into account when considering approaches to the management of COVID-19 AKI throughout the disease course. www.ADQI.org, (<https://creativecommons.org/licenses/by/2.0/>).

B- RRT & extracorporeal support for AKI in COVID-19 patients

- If conservative management fails, RRT should be considered in pts with volume overload, especially those with refractory hypoxemia.
- In pts with COVID-19 and AKI, early initiation of RRT & sequential extracorporeal organ support (ECOS) seem to provide adequate organ support & prevent progression of disease severity ([figure 2](#)).
- This approach, however, should be tested in future clinical trials.
- CRRT is the preferred modality in hemodynamically unstable pts with COVID-19.

Figure 2 Management of AKI necessitating renal replacement therapy in pts with COVID-19

Critically ill patients with AKI necessitating RRT

- Management recommendations focus on AKI in COVID-19 rather than usual practice for AKI, & are based largely on the clinical experience.
- All therapeutic options need to be tested in rigorous studies & ideally RCTs in the context of COVID-19. In the absence of specific therapies, all options should be considered according to each patient's needs.
- The extracorporeal therapies included in the figure for consideration can be complementary to pharmacological support.

Conjunction with ECMO

haemodynamic tolerance

calculation)

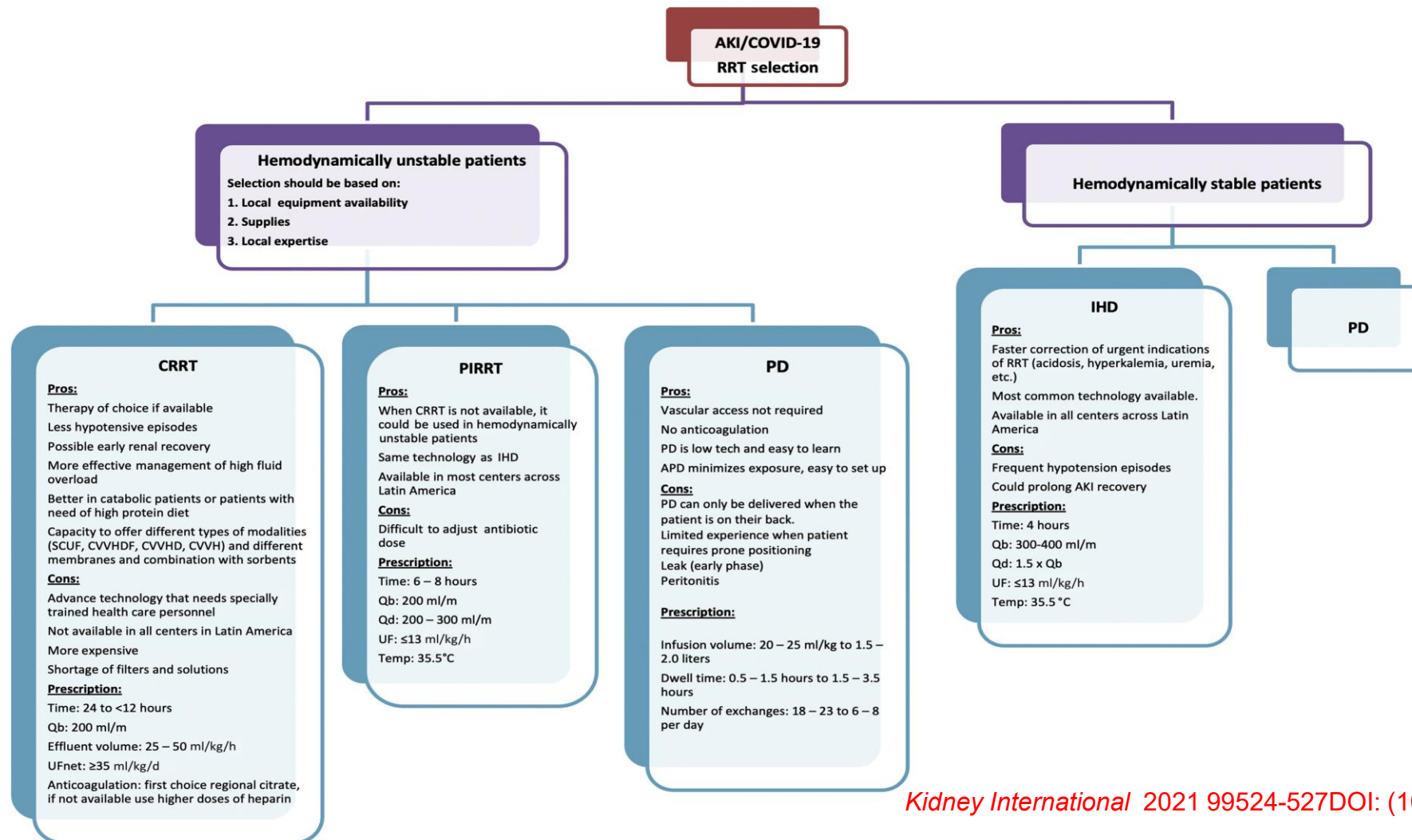
INDICATIONS AND MODALITIES OF RRT IN CRITICALLY ILL COVID-19 PATIENTS

- Indications of RRT, & the modality of RRT seem to be no different than in other AKI settings.
- Extracorporeal therapies have also been studied as potential treatments for removal of cytokines in pts with sepsis, & therefore, potentially considered for prevention of CRS-induced organ damage in critically ill pts with COVID-19.
- **The indications of RRT should be those generally accepted to treatment of AKI, such as:**
 - Restoration of the immune homeostasis,
 - Removal of inflammatory mediators which lead to ARDS, &
 - Prevention of fluid overload being an independent risk factor for ICU mortality .

INDICATIONS AND MODALITIES OF RRT IN CRITICALLY ILL COVID-19 PATIENTS

- Fluid overload may compromise the respiratory system by inducing several complications including pulmonary edema.
- Although, there is no sufficient data to support the early initiation of RRT in COVID-19 pts with AKI, , early initiation (& continuation) of RRT in critically ill pts and pts with sepsis seem to attenuate the disease severity & improve outcomes
- The coexistence of other comorbidities such as DM & HTN, in addition to the severity of respiratory disease severity determine the treatment modality.
- The currently used modalities of RRT include CRRT (most used), PIHD, IHD, & PD ([Figure 3](#)).

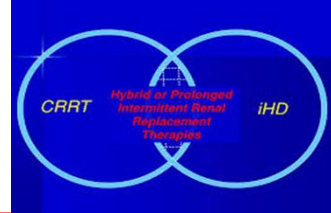
Ronco C, et al., Blood Purif. 2020;49:255–8.



Kidney International 2021 99524-527DOI: (10.1016/j.kint.2020.12.021)

Figure 3: Proposed approach for the provision of (RRT) and modality selection during coronavirus disease 2019 (COVID-19) pandemic. Overview of a stepwise approach for providing RRT to pts with COVID-19; in hemodynamically unstable pts, (CRRT) is the therapy of choice if available, and (PIRRT) and (PD) can be used if CRRT is not available. In hemodynamically stable pts, (IHD) and PD can be used. Selection should be based on local equipment availability, supplies, and local expertise.

1- Continuous renal replacement therapy



- The main indication for selecting CRRT over IHD is **hemodynamic instability & high catabolic states**.
- For COVID-19 pts with AKI, CRRT is indicated in pts with stage 3 AKI (defined as either an \uparrow in cr. levels of a 3-fold from baseline or cr. ≥ 4.0 mg/dl or a \downarrow in the amount of UOP: < 0.3 ml/kg/h for ≥ 24 h or anuria for ≥ 12 h) in pts hospitalized in ICU.
- In general, prior to the COVID-19 pandemic, CRRT represented the modality of choice for hemodynamically unstable pts requiring RRT.
- However, after the outbreak, it has become difficult to allocate HD machines to COVID-19 pts with AKI due to infection control. (currently, CRRT ranges from 5% to 52%)

Nalesso F, et al., J Clin Med. 2020;9:1529.

Adapa S, et al., J Clin Med Res.2020;12:276–85

1- Continuous renal replacement therapy



- CRRT dosing can be generally applied according to (KDIGO) guidelines, HVHF at a dose of 6 L/h has been found as effective in improving the SOFA scores in pts with sepsis; suggesting a potential benefit of CRRT in pts with COVID-19 & sepsis.
- Hypercoagulability in pts with COVID-19 is an important concern. Clotting of the CRRT memb. is a major limitation to care, → blood loss, inefficient dialysis, & exhausts resources
- Regional anticoagulation using UFH or citrate (less effective), or systemic anticoagulation with UFH or LMW one should be used with **QB >120 ml/min** to prevent premature circuit clotting.
- The 25th **ADQI** Workgroup stated that **“the use of CVVHD or CVVHDF modality & minimizing post-filter replacement fluid will ↓ the risk of circuit clotting.”** (effl.F R 20–25 ml/kg/h)

Endres P, et al. J Thromb Thrombolysis. 2021;51:966–70.

Nadim MK, et al., (ADQI) Workgroup. Nat Rev Nephrol. 2020;16:747–64.

CRRT Anticoagulation Guidelines – COVID-19

Goal: Maximize CRRT circuit survival in any patient running continuously to max 72 hrs

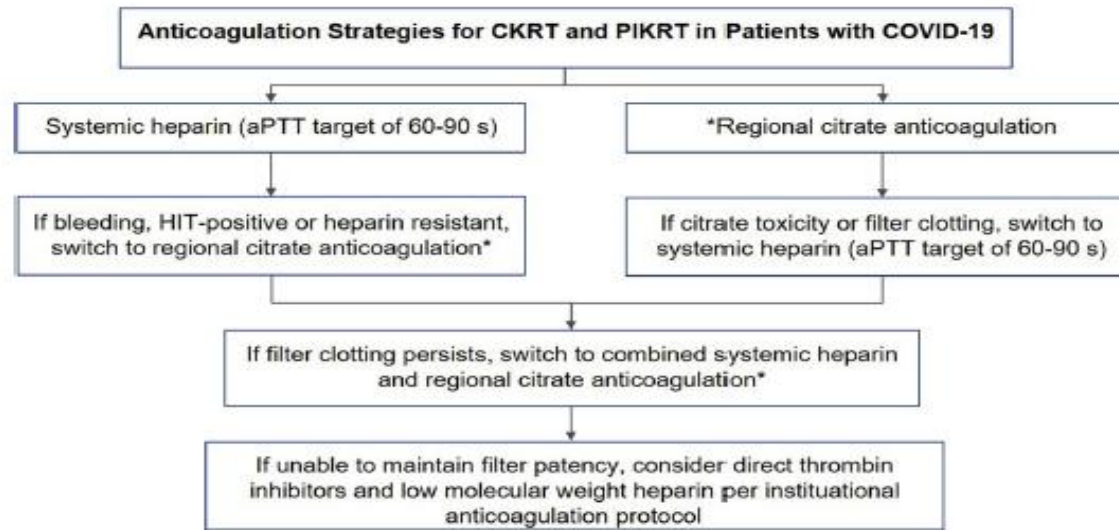


Figure 1. Anticoagulation strategies for kidney replacement therapy in Patients with COVID-19. Abbreviations: aPTT: activated partial thromboplastin time; CKRT, continuous kidney replacement therapy; COVID-19, coronavirus disease 2019; HIT, heparin-induced thrombocytopenia; PIKRT, prolonged intermittent kidney replacement therapy. Ensure appropriate catheter length to reduce risk of clotting. Maintain filtration fraction of < 20 . *Use citrate anticoagulation only if an existing protocol is available at the institution. Implementation of citrate anticoagulation protocol requires careful advanced planning, and education of physicians and nurses to prevent adverse events. We do not recommend initiation of a new regional citrate anticoagulation during acute surge.

2- Prolonged intermittent hemodialysis



PIRRT

means

Prolonged Intermittent Renal Replacement Therapy

by acronymsandslang.com

**Kidney and
Blood Pressure
Research**

Kidney Blood Press Res 2020;45:775–783

DOI: 10.1159/000511914

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www.karger.com/kbr

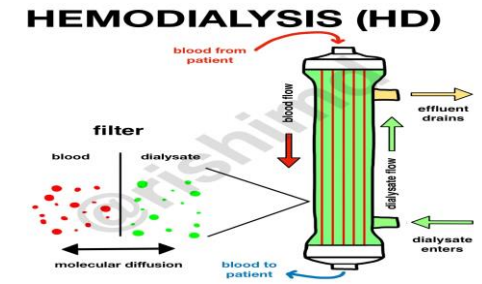
Claire-Del Granado et al.: Dialysis for AKI in COVID-19 Patients

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Table 2. Differences between PIRRT and CRRT

PIRRT	CRRT
Higher fluid shifts, increased risk of hypotension	Hemodynamic stability, reduced risk for cerebral edema
Requires conventional equipment, simple procedure	Requires especial equipment
Easy to perform, patient mobility, flexible timing – 12 h/day	Need for trained personnel
Lower cost	Higher cost
Anticoagulation with heparin if needed	Anticoagulation not always required but if it is required heparin or citrate are the most common strategies
Higher risk of bleeding (systemic anticoagulation)	Lower risk of bleeding if regional anticoagulation is used
Risk for hypophosphatemia	More precise solute and volume control, adequate nutritional support is possible
Easier to perform and allows the use of one machine for multiple patients	Limited to one or two patients with the same equipment

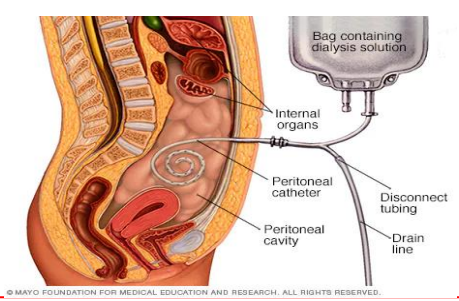
3- Conventional IHD



- The use of IHD in critically ill pts with COVID-19 should be limited to circumstances of unavailable CRRT or PIHD; being suitable only for ICU pts with severe AKI & ↓BP
- The higher flow rates needed to improve the efficacy of dialysis, requires close monitoring throughout the session to avoid hemodynamic instabilities.
- This requires an HCP to be in contact with the pat for the entire duration of session; making IHD the least ideal therapeutic modality for pts infected with COVID-19.
- Further studies are needed to address the key points of IHD prescription for AKI pts in COVID-19 pandemic.

ASN. Recommendations on the care of hospitalized pts with COVID-19 & kidney failure requiring RRT; 2020.

4- Peritoneal dialysis



- There are multiple advantages of using PD in COVID-19 infected pts with severe AKI.
- **First**, there is no need for vascular access; which is also preferable to avoid in view of the coexisting coagulopathy.
- **Second**, PD can be conducted with few resources, it does not require expensive machinery & supplies of CRRT or IHD.
- **Third**, education of staff on performing PD is safe, feasible during a pandemic, & less technically challenging compared to other HD techniques.
- **Fourth**, unlike HD, PD does not require water system for dialysate supply, which represented a major obstacle in multiple ICU locations temporarily constructed in response to the COVID-19 pandemic.

4- Peritoneal dialysis

- **Fifth**, PD catheter can be performed at the bedside . It has been revealed that an unplanned start to PD right after the insertion of PD catheter is an efficient & safe procedure
- The implementation of an acute PD program for COVID-19 pts with severe AKI requiring RRT was found to successfully mitigate the demand for RRT during COVID-19 pandemic's peak.
- Efficacy ?: PD has been found to be comparable to HD in management of pts with AKI as regard metabolic control, mortality, & kidney function recovery rates.
- PD appears to be an effective & feasible method for treating critically ill COVID-19 infected pts with AKI, especially in hospitals where more sophisticated technologies are not available.

Sourial MY, et al., Am J Kidney Dis. 2020;76:401–6.

Table 3 Recommendations for RRT use in patients with COVID-19 AKI			Table 4 RRT modality options for patients with COVID-19 AKI		
Considerations	RRT management for COVID-19 AKI	RRT management during a period of increased RRT demand (RRT surge)	Modality	Advantages in COVID-19 AKI	Disadvantages in COVID-19 AKI
RRT indications	<p>Consider acute RRT when metabolic and fluid demands exceed total kidney capacity</p> <p>Consider the broader clinical context and conditions that can be modified by RRT rather than BUN or creatinine alone when determining the need for RRT initiation</p>	<p>Consider a judicious and safe use of intravenous bicarbonate, potassium binding resins and diuretics to forestall RRT initiation</p> <p>RRT should be initiated immediately if there is a failure of conservative measures or clinical deterioration</p>	IHD	<p>Widely available</p> <p>Allows treatment of several patients with the same machine in a given day</p> <p>Higher blood flow may reduce risk of clotting</p>	<p>Less effective in reaching daily fluid balance goals</p> <p>Can lead to or exacerbate haemodynamic instability</p> <p>Usually requires a dedicated HD nurse or other staff in addition to an ICU nurse (increasing staff exposure to the isolation environment)</p>
Modality	<p>Selection of modality should be based on patient needs, local expertise and availability of staff and equipment</p> <p>Prolonged modes of RRT (CRRT, PIRRT, SLED or PD) should be considered for haemodynamically unstable patients, those with marked fluid overload, or in whom shifts in fluid balance are poorly tolerated</p> <p>CVVHD or CVVHDF modality and minimizing post-filter replacement fluid in patients who are on CRRT will decrease the filtration fraction and reduce the risk of circuit clotting</p>	<p>Modality choice may be affected by the supply of disposable materials (dialyzer filters, machine tubing sets, dialysis solutions and anticoagulation medications), machine availability and the availability of appropriately trained staff to operate machines and safely deliver RRT</p> <p>Advantages of PIRRT or IHD may include a reduced need for anticoagulation and shorter duration of therapy session, thereby optimizing machine and human resources to increase the number of patients who can receive RRT per day</p> <p>In the event of limited machine availability, consider shorter durations of IHD or use of CRRT machines for PIRRT (i.e. in a shift-based approach)</p> <p>If IHD or CRRT machine availability is limited, consider use of acute PD, as PD requires relatively less equipment, infrastructure and resources without a need for RRT-related anticoagulation</p>	PIRRT: IHD or CRRT	<p>Less likely than other modalities to exacerbate haemodynamic instability</p> <p>Allows treatment of several patients with the same machine in a given day</p> <p>Option for higher blood flow, which may reduce risk of circuit clotting</p>	<p>Not as widely available as other modalities (i.e. hospital protocols are not widely established)</p> <p>Given the procoagulant nature of COVID-19, systemic anticoagulation may be necessary</p> <p>Challenges and uncertainty of drug dosing, especially for antimicrobial and/or COVID-19 therapeutics</p>
RRT dose	<p>CRRT: delivered effluent flow rate of 20–25 ml/kg/h (prescribed dose of 25–30 ml/kg/h)</p> <p>IHD or PIRRT: minimum three times per week (alternate days)</p> <p>Interruption of prolonged RRT modality (CRRT, PIRRT or SLED) sessions due to circuit clotting can have a substantial impact on the actual delivered dose and the dose may therefore need to be adjusted to account for this disruption</p>	<p>Consider using lower than usual flow rates once metabolic control has been achieved if concerns exist about the availability of consumables (e.g. filters or dialysate solutions)</p> <p>If shorter durations of IHD or CRRT machines for PIRRT are prescribed or required, we recommend that appropriate adjustments are made in fluid removal targets and RRT dose to achieve appropriate fluid balance targets and metabolic control (e.g. an increase in effluent dose)</p>	CRRT	<p>Achieves steady-state control of small solutes and acid-base status</p> <p>Least likely to exacerbate haemodynamic instability</p> <p>Easy to achieve net negative fluid balance and achieve fluid balance targets with greater haemodynamic stability</p> <p>Can often be performed by the patient's bedside in the ICU, limiting staff contact with the isolation environment</p>	<p>Not as widely available as other modalities outside of resource-rich settings or tertiary centres</p> <p>Requires one machine per patient per day</p> <p>Requires ICU settings and may require 1:1 nursing ratio depending on institutional policies</p> <p>Given the procoagulable nature of COVID-19, anticoagulation is recommended and may require systemic therapeutic anticoagulation</p> <p>Increased frequency circuit clotting may lead to a lower delivered dose, inability to achieve fluid balance targets and increased resource utilization (which may have supply chain impacts)</p>
Vascular access	<p>Right IJ is the preferred site</p> <p>Prone position, obesity and hypercoagulability may affect vascular access performance</p>	<p>No anticipated differences in preferred vascular access sites during an RRT surge</p> <p>Develop local expertise and teams for acute PD catheter insertion (ICU bedside versus operating room)</p>	PD	<p>Widely available</p> <p>No circuit clotting concerns</p> <p>No venous access required</p> <p>Less likely to exacerbate haemodynamic instability</p> <p>Less nursing exposure with the use of automated cyclers</p>	<p>May be more challenging in patients in prone positions</p> <p>Risk of peri-catheter leaks</p> <p>Protocols and policies for acute PD are not available at all sites. Requires technical expertise to place catheters</p> <p>May require rapid implementation of training regimen for renal nurses and clinicians</p>

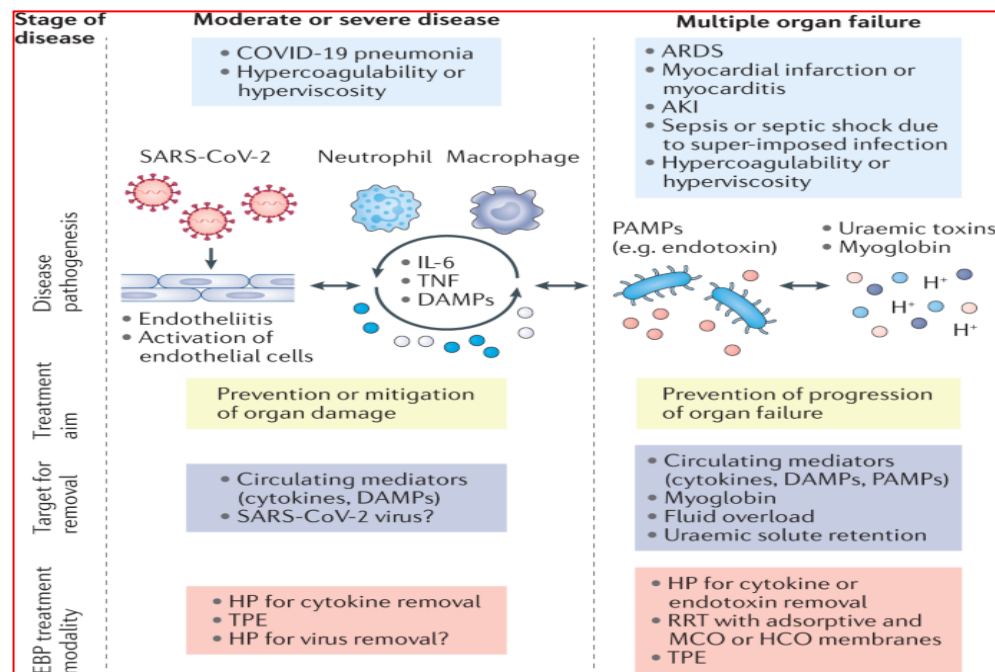
C - EXTRACORPOREAL BLOOD PURIFICATION THERAPIES FOR CYTOKINES REMOVAL

- The immune response to SARS-CoV-2 may lead to a pathophysiological condition of a “cytokine storm” which represents a severe CRS leading to multi-organ failure .
- The blood purification systems like (TPE), adsorption, perfusion, blood/plasma filtration can remove inflammatory cytokines to an extent that it blocks CRS.
- These therapies, while considered as “**under scientific investigation,**” still represent a therapeutic option for pts with severe CRS. They include:

Ronco C, et al. Blood Purif. 2021;50: 17–27.

Potential extracorporeal blood purification Rx options based on underlying COVID-19 pathophysiology.

Nature Reviews Nephrology volume 16, 747–764 (2020)



EBP techniques

Which EBP techniques can potentially be used to remove circulating molecules implicated in the pathophysiology of COVID-19?

1. **Haemoperfusion** techniques can remove inflammatory molecules, DAMPs and PAMPs, including SARS-CoV-2 particles.
2. **(TPE)** can remove inflammatory mediators and proteins associated with hypercoagulability.
3. **CRRT** with surface-modified AN69 or polymethylmethacrylate membranes can remove target molecules by adsorption, whereas CRRT with medium cut-off or high cut-off membranes can remove target molecules by diffusion or convection.

1- Continuous renal replacement therapy



- CRRT plus haemoperfusion seem to be effective in CRS; it does not only support vital organ functions like heart, lungs, kidneys, & liver but also avoid organ damage by removing excess inflammatory mediators.
- CRRT has been proven to effectively eliminate inflammatory cytokines such as (CRP), (IL-1), & (IL-6).
- High-volume hemofiltration (>50 ml/kg/h) allows greater removal of hydrophilic middle molecular weight inflammatory molecules.

MacLaren G, et al. JAMA. 2020;323:1245–6.

2- Haemoperfusion

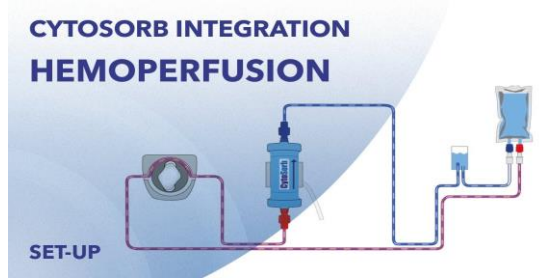


Table 3. Adsorbent membranes and cartridges in Latin America

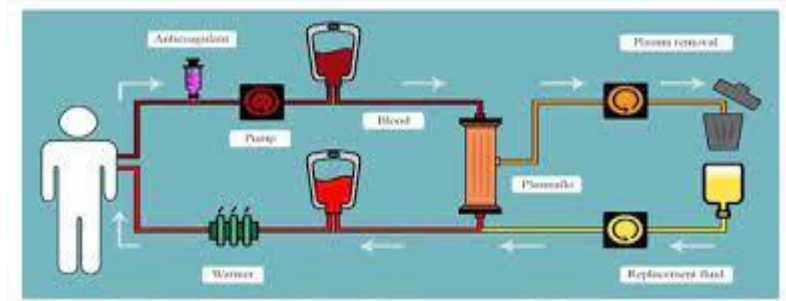
Adv Chronic Kidney Dis. 2020;27(5):377-382

Membrane	Properties	Mechanism	Available countries
oXiris	Membrane AN69, covered with heparin	Absorption of endotoxines and cytokines	Mexico, Colombia, Panama, Costa Rica, and Brazil
Cytosorb	Porous polymer beads	Absorption of endotoxines and myoglobin	Panama, Chile, and Mexico; Argentina and Brazil (to start)
Thoramixyn	Synthetic membrane coated with polymyxin B	Absorption of endotoxines	Not available
HA330	Resin-directed hemoadsorption	Absorption of endotoxines	Argentina, Colombia, Ecuador, and Chile

Malard B, et al. *Intensive Care Med Exp.* 2018; **6**: 1– 13.

Kobashi S, et al. *Acute Med Surg.* 2019; **6**: 60– 7.

3- Therapeutic plasma exchange



- Plasmapheresis & plasma exchange have **not** been widely studied for this indication.
- There is **no** consensus on the routine use of TPE in pts with COVID-19 related CRS considering the scarce evidence of small studies suggesting that TPE may ↓ mortality in pts with sepsis.
- Lectin affinity plasmapheresis is another adjunctive potential extracorporeal therapy for coronavirus trapping based on the high affinity between the viral envelope & lectins so that it can ↓ the viremia.
- The extracorporeal blood purification techniques may represent promising future therapeutic tools for management of CRS, however, they can similarly remove essential drugs & antibiotics which should be also considered in pts with COVID-19.

Malard B, et al. *Intensive Care Med Exp.* 2018; **6**: 1– 13.

Temel S & Sungur M. *J Crit Intensive Care.* 2020; **11**(Suppl): 32.

4- ECMO

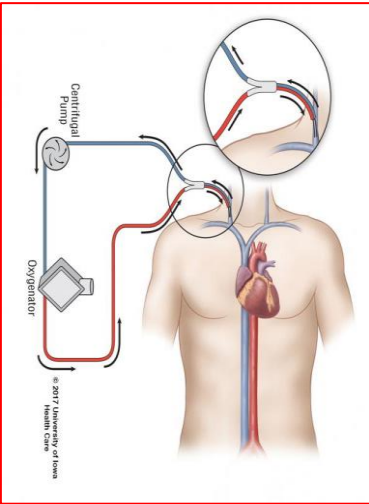
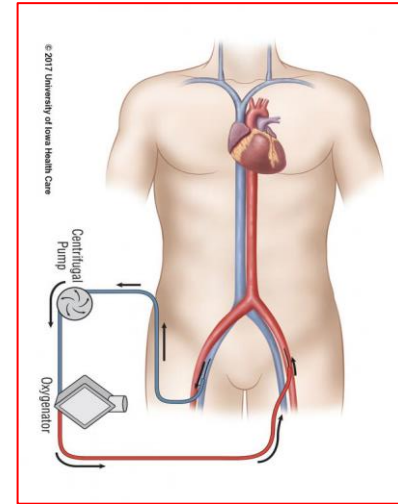


Table 3 Indications and Contraindications for ECMO use in COVID-19 patients

	Items	Explanation
Indications	(1) Refractory ARDS despite optimal ventilation strategies (curare use, prone positioning, inhaled nitric oxide, etc.)	<ol style="list-style-type: none"> Prone positioning is strongly recommended unless clear contraindications to prone positioning, as hemodynamic instability could justify ECMO employ without previous clinical trial in prone positioning Inhaled nitric oxide could be considered, but it is not mandatory before using ECMO
	(2) Prolonged mechanical ventilation < 7 d	Prolonged mechanical ventilation with ventilation settings ($FiO_2 > 0.9$, plateau pressure > 30 cmH_2O) could cause irreversible lungs injury and multiple organ damage
	(3) The use of ECMO should be considered when the risk of death is more than 50%, and should be started when the risk of death reaches or exceeds 80%	<ol style="list-style-type: none"> Mortality risk greater than 50% is measured as $PaO_2/FiO_2 < 150$ and $FiO_2 > 90\%$ and/or Murray score 2–3 [62, 63]; Mortality risk greater than 80% is measured as $PaO_2/FiO_2 < 100$ and $FiO_2 > 90\%$ and/or Murray score 3–4 despite optimal care for 6 h or less Earlier use of ECMO after respiratory failure onset (1–2 days) is more likely to benefit patients with COVID-19
	(4) Severe air leak syndrome	
	(5) Complicated with severe myocarditis or cardiogenic shock	Cardiogenic shock is defined as $CI < 1.8 L/min/m^2$ or $MAP < 60 mmHg$ with maximum dose of vasoactive drugs (nor-epinephrine > 1 $mcg/kg/min$) or Intra-Aortic Balloon Pump
Con-indications	(1) Age ≥ 65 years (relative contraindications)	
	(2) Significant underlying comorbidities that cannot be recovered	Comorbidities include: $CKD \geq III$, cirrhosis, dementia, advanced lung disease, uncontrolled diabetes with chronic end-organ dysfunction, severe peripheral vascular disease, severe brain dysfunction, severe damage to the central nervous system, and advanced malignant tumors
	(3) Severe immunosuppression	Absolute neutrophil count $< 0.4 \times 10^9 /L$
	(4) Contraindications to anticoagulation	Contraindications to anticoagulation include: liver failure caused by COVID-19 combined with severe coagulopathy, major bleeding, and recent or enlarged intracranial bleeding
	(5) Severe multiple organ failure	
	(6) Patients who are diagnosed with acute aortic dissection	
	(7) Inability to accept blood products	



Conclusion

Pts with COVID-19 complicated with severe ARDS have a high mortality rate. The use of ECMO can further complicate the pathophysiological state in COVID-19 pts. However, several studies have reported that the appropriate use of ECMO improves the prognosis of pts. COVID-19 is a major cause of ARDS, which causes most COVID-19-related deaths. However, these recommendations should continue to be updated & improved as additional high-quality trials are completed.

5- MCO dialyzers

Nephron

Clinical Practice: Review Article

Nephron 2020;144:550–554
DOI: 10.1159/000509807

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Published online: August 4, 2020

Rationale for Medium Cutoff Membranes in COVID-19 Patients Requiring Renal Replacement Therapy

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Conclusion

Recent clinical trials demonstrated consistent results regarding the application of MCO membranes in pts on maintenance HD. These trials confirmed long-term safety and long-term sustained ↓ in the concentrations of large uremic toxins, cytokines, & FLC with MCO-HD when compared to conventional HF-HD. In the context of the COVID-19 pandemic, the authors presented the rationale that supports the use of MCO dialyzers in the chronic dialysis regimen. This strategy has been used in many dialysis facilities across Italy with the scope to prevent severe presentations of COVID-19

D- SUMMARY OF INTERNATIONAL RECOMMENDATIONS AND GUIDELINES CONCERNING RRT IN CRITICALLY ILL pts WITH COVID-19:



- 1 Wuhan expert statement

- In general, front-line experts in Wuhan, China fighting against the COVID-19 pandemic developed an expert statement regarding the management of critically ill COVID-19 pts. They suggest the use of KDIGO criteria for the diagnosis of AKI in COVID-19 pts. They also suggested using CRRT for the critical cases complicated by severe AKI, or cytokine storm syndrome (**expert opinion**).



- 2 American society of nephrology

- The ASN released recommendations for care of hospitalized pts with COVID-19 and kidney failure requiring RRT ; among which we highlight the following Indications to start RRT are the same as in other pts with AKI :
- 1-The preferred modality for RRT in critically ill pts is CRRT or prolonged intermittent renal replacement therapies (PIRRT).
- 2- CRRT machines are preferred over IHD in setting of biocontainment/isolation, as IHD requires 1:1 HD nursing support.
- 3- IHD can also be performed, if CRRT and PIRRT equipment are not available.

Shang Y, Pet al., Ann Intensive Care. 2020;10(1):1–24.

Kdigo A. Work group. Kidney Int Suppl. 2012;2:1–138.

American Society of Nephrology. 2020.



- 3 National institutes of health
- The NIH stated the following recommendations regarding the management of severe AKI in COVID-19 pts :
- For critically ill pts with COVID-19 who have (AKI) and who develop indications for (RRT), the COVID-19 Treatment Guidelines Panel recommends CRRT, if available (BIII).
- If CRRT is not available, the Panel recommends PIRRT rather than IHD (BIII).
- The panel suggests using the same indications for RRT in pts with COVID-19 as those used for other critically ill pts.
- As RRT modalities have not been compared in COVID-19 pts; the Panel's recommendations are motivated by the desire to minimize the risk of viral transmission to health care workers; therefore, CRRT is preferable as it does not require nursing staff to enter the patient's room to begin & end dialysis sessions.
- CRRT & PIRRT are both preferable to IHD because neither requires a dedicated HD nurse.

OPEN

 Check for updates

COVID-19-associated acute kidney injury: consensus report of the 25th Acute Disease Quality Initiative (ADQI) Workgroup

Mitra K. Nadim¹, Lui G. Forni^{2,3}, Ravindra L. Mehta⁴, Michael J. Connor Jr⁵,

- 4 Consensus report of the 25th ADQI workgroup
- The panel of the 25th ADQI Workgroup indicated that there is no specific evidence to suggest that COVID-19 AKI should be managed differently from other causes of AKI in critically ill pts.
- The following recommendations have been stated : The use of US for insertion of vascular access and RRT dose delivery remain based on KDIGO AKI guidelines (evidence level: 1A).
- Timing of RRT initiation, vascular access site and modality of acute RRT should be based on patient needs, local expertise and the availability of staff and equipment (not graded).
- As COVID-19 often induces a hypercoagulable state, if using CRRT, the panel suggested use of CVVHD or CVVHDF to ↓ filtration fraction & ↓ the risk of circuit clotting (evidence level: 2C)

Nadim MK et al., (ADQI) Workgroup. Nat Rev Nephrol. 2020;16:747–64.

E- The precautions that should be adopted by HCPs conducting dialysis treatment to critically ill pts with COVID-19:

- Prevention of transmission of infection to HCPs conducting dialysis sessions is mandatory.
- Dialysis staff should follow standard contact instructions, including isolation gowns, gloves, N-95 or higher-level respirator or facemask masks, & eye protection (shields or goggles).
- It is perfect to limit the time of contact between dialysis staff, & COVID-19 pts in the ICU.
- Nephrologists should contact ICU teams to rely on physical examination findings to minimize patient contact.
- The facility should provide telemedicine for monitoring pts through a glass door, or camera
- Ideally, in facilities, where ICU nurses are trained on the use of CRRT, HD nurses should bring & set up the CRRT machine outside the isolation ICU.

E- The precautions that should be adopted by HCPs conducting dialysis treatment to critically ill pts with COVID-19:

- Then, the ICU nurse will take the machine into the ICU & connect the pt in the room in order to minimize exposure of medical staff, & use of PPEs
- Disinfection protocols for the dialysis setting should be implemented.
- This should include wipes for the dialysis machine, chair, dialysis station surfaces located within 6 feet of pts, & all non-dedicated, non-disposable medical equipment used for dialysis treatment including BP cuffs & stethoscopes.
- Cleaning & disinfection is performed with a disinfectant made of sodium hypochlorite solution containing 1000 ppm of active chlorine.
- Dialysis effluent from COVID-19 pts can be disposed of per standard facility protocols. The genomic material of SARS-CoV2 was detected in CRRT effluent in an earlier report.

E- The precautions that should be adopted by HCPs conducting dialysis treatment to critically ill pts with COVID-19:

- HCPs caring for the patient in the ICU or disposing of effluent from the CRRT machine should wear recommended PPE.
- PD effluent should be mixed with 500 mg/L chlorine-containing solution for 1 h & poured into the toilet.
- Adequate rest for HCP is mandatory to concentrate fully at work to prevent accidental contamination.
- The mental & physical health of the medical staff is very important & should be monitored continuously for any disturbances.

Katagiri D, et al., Blood Purif. 2021;50:129–31.

TABLE 2 – RRT Equipment Disinfection

	<u>ICU Cohort Strategy</u>	<u>ICU Room Strategy</u>
At <u>end</u> of RRT session	All disposable RRT machine equipment (tubing/filter sets, CRRT solutions bags, etc) should be discarded as directed by hospital infection control & policy.	All disposable RRT machine equipment (tubing/filter sets, CRRT solutions bags, etc) should be discarded as directed by hospital infection control & policy.
RRT Machine Disinfection	RRT Machine (Prismaflex or Prismax) surface should be disinfected using <u>“Sani-Cloth Germicidal Wipes” (PURPLE Top)</u> No additional disinfection steps required prior to use on next pandemic patient.	RRT Machine (Prismaflex or Prismax) surface should be disinfected using <u>“Sani-Cloth Germicidal Wipes” (PURPLE Top)</u> No additional disinfection steps required before machine can: <ul style="list-style-type: none"> • leave pandemic patient’s room • move to another patient’s room • used on a different pandemic or non-pandemic patient

TABLE 1

	<u>ICU Cohort Strategy</u>	<u>ICU Room Strategy</u>
Location of pandemic ICU patients	Co-locating / cohorting of all suspected & confirmed pandemic patients in specific ICUs at the ICU level	Certain ICU rooms in the hospital designated for suspected or confirmed pandemic patients
Location of non-pandemic ICU patients	Non-pandemic patients are excluded from designated pandemic ICU	Non-pandemic patients are co-located in any given ICU with pandemic patients
PPE zone	Entire pandemic ICU <u>may</u> be designated a PPE zone in which PPE would be worn at all times while in the ICU (per hospital infection control guidelines & recommendations)	PPE zone is at the patient room level . The rest of the ICU is <u>not</u> considered PPE zone (i.e. it is not contaminated)
PPE don/doff	Don occurs prior to entering the designated ICU Doff occurs as leaving the designated ICU	Don occurs prior to entering the individual pandemic patient room Doff occurs as leaving the individual pandemic patient room

In a respiratory pandemic critical-illness ICU surge situation, EHC will likely employ 1 of 2 ICU admission/census strategy (see **Table 1**): Further guidance regarding RRT Machine disinfection AND approved disinfection cleaning products for SARS-CoV-2 (COVID-19) can be found at: (see **Table 2**)

1. <https://www.cdc.gov/coronavirus/2019-ncov/healthcare-facilities/dialysis.html>
2. <https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2>
3. Emory Healthcare ., Last updated: 4/6/2020

Further research

- Further research is needed
- 1- obtain adequate evidence
- 2- develop new approaches
- Novel tubular damage biomarkers to establish their value in AKI prediction
- Fostering an international research culture will be crucial to rigorously test emerging therapeutic approaches in COVID-19 who are at risk of AKI

Panel: Research priorities to improve management of acute kidney injury in COVID-19

- Research is needed to establish the value of novel tubular damage biomarkers in prediction and management of acute kidney injury (AKI) in patients with coronavirus disease 2019 (COVID-19); studies should also focus on their potential to guide optimal fluid management, ventilation strategies, and recruitment manoeuvres in COVID-19
- Clinical trials should investigate the early initiation of renal replacement therapy (RRT) and sequential extracorporeal therapies as means to provide adequate organ support and to prevent progression of COVID-19 severity
- Trials are needed to clarify the role of haemadsorption and other extracorporeal systems for cytokine removal in cytokine storm scenarios in patients with COVID-19
- Studies should aim to clarify the safety and feasibility of low-flow extracorporeal carbon dioxide removal using RRT platforms in hypercapnic patients with COVID-19, acute respiratory distress syndrome, and AKI
- Studies should establish the proportion of patients with a superimposed bacterial sepsis and the role of sequential extracorporeal therapy (endotoxin removal, cytokine removal and immunomodulation, extracorporeal organ support) in their management

[Intensive Care Med.](#) 2020 Jul; 8(7): 738–742

secondary to COVID-19, to:

discussed here, and to

[Panel](#)).

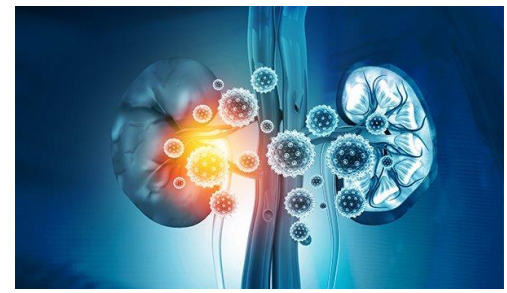
future RCTs to investigate

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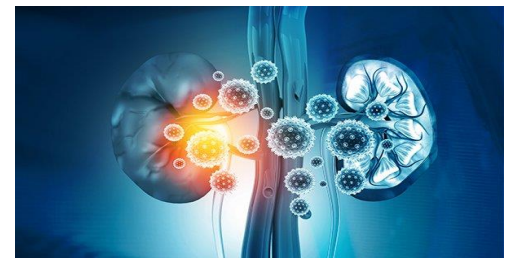
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Conclusion



- Patients with COVID-19 have an ↑ risk of AKI and death. The etiologies of AKI are multifactorial, & data from larger case series are needed.
- Management of AKI is supportive, & extracorporeal therapies may be required in critically ill pts.
- Healthcare systems should closely track dialysis resources, & best-care practices should be shared to optimize care in settings of limited resources.
- The treatment of acute kidney injury, indications of RRT, & the modality of RRT seem to be no different than in other settings.

Conclusion



- CRRT & PIHD therapies are preferred over IHD in terms of minimizing viral transmission to health care providers.
- PD may represent a valuable therapeutic option in the current pandemic especially in hospitals where more sophisticated technologies are not available.
- Discussions on a case-by-case basis should be held at the bedside by skilled healthcare providers & extracorporeal blood purification treatments **never** administered as part of routine care.
- **A large body of evidence is daily growing throughout the current pandemic.**
- Further studies concerning RRT in AKI pts with coronavirus disease 2019 are highly warranted to address the targeted management protocols.

REFERENCES

RESEARCH ARTICLE

COVID-19-associated acute kidney injury patients treated with renal replacement therapy in the intensive care unit: A multicenter study in São Paulo, Brazil

Farid Samaan^{1,2,3,4*}, Elisa Carneiro de Paula^{5†}, Fabrizzio Batista Guimarães de Lima

American Society of Nephrology

Release Date: March 21, 2020

Please note: Due to rapidly changing information and guidance from the CDC, updates will be provided as new information becomes available.

RECOMMENDATIONS ON THE CARE OF HOSPITALIZED PATIENTS WITH COVID-19 AND KIDNEY FAILURE REQUIRING RENAL REPLACEMENT THERAPY

REVIEW



Renal replacement therapy for critically ill patients with COVID-19-associated acute kidney injury: A review of current knowledge

Rasha Samir Shemies¹  | Eman Nagy¹  | Dalia Younis¹ | Hussein Sheashaa²

Shruti Gupta et al, *JASN* 32: 161-176, 2021. doi: <https://doi.org/10.1681/ASN.2020060897>

CLINICAL RESEARCH www.jasn.org

AKI Treated with Renal Replacement Therapy in Critically Ill Patients with COVID-19

ACKD

Management of Acute Kidney Injury in Coronavirus Disease 2019



Sana Shaikh, Gonzalo Matzumura Umemoto, and Anitha Vijayan

Acute kidney injury is a common complication in hospitalized patients with coronavirus disease 2019. Similar to acute kidney injury associated with other conditions such as sepsis and cardiac surgery, morbidity and mortality are much higher in patients with coronavirus disease 2019 who develop acute kidney injury, especially in the intensive care unit. Management of coronavirus disease 2019-associated acute kidney injury with kidney replacement therapy should follow existing recommendations regarding modality, dose, and timing of initiation. However, patients with coronavirus disease 2019 are very hypercoagulable, and close vigilance to anticoagulation strategies is necessary to prevent circuit clotting. During situations of acute surge, where demand for kidney replacement therapy outweighs supplies, conservative measures have to be implemented to safely delay kidney replacement therapy. A collaborative effort and careful planning is needed to conserve dialysis supplies, to ensure that treatment can be safely delivered to every patient who will benefit for kidney replacement therapy.

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Key Words: Acute kidney injury, COVID-19, Kidney replacement therapy

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Research**

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Editorial

Renal Replacement Therapy for Acute Kidney Injury in COVID-19 Patients in Latin America

Rolando Claire-Del Granado^a Gustavo Casas-Aparicio^b
Guillermo Rosa-Diez^c Lilia Rizo-Topete^d Daniela Ponce^e

Care of Critically Ill Adult Patients With COVID-19

Last Updated: December 16, 2021

Summary Recommendations

<https://www.covid19treatmentguidelines.nih.gov/>

Viewpoint

Management of acute kidney injury in patients with COVID-19

Claudio Ronco, Thiago Reis, Faeq Husain-Syed

The outbreak of coronavirus disease 2019 (COVID-19) has rapidly evolved into a global pandemic. Most patients with COVID-19 have mild symptoms, but about 5% develop severe symptoms, which can include acute respiratory distress syndrome, septic shock, and multiple organ failure. Kidney involvement is frequent, with clinical presentation ranging from mild proteinuria to progressive acute kidney injury (AKI) necessitating renal replacement therapy (RRT). An understanding of the pathophysiology and mechanisms of kidney damage and AKI in the setting of critical illness and COVID-19 is emerging, although further research is needed to identify patients at risk of AKI and to guide management strategies. As no specific treatment options exist for AKI secondary to COVID-19, intensive care is largely supportive. Current approaches to prevention and management of AKI, and identification of potential indications for use of RRT and sequential extracorporeal therapies, are based mainly on clinical experience, and AKI strategies are adapted empirically to patients with COVID-19. International collaborative and cross-disciplinary research is needed to obtain adequate evidence to support current clinical approaches and to develop new approaches to management.

Lancet Respir Med 2020

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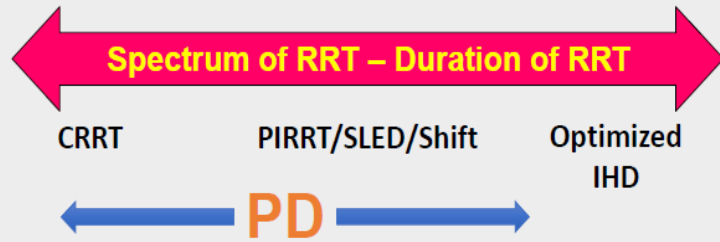
Thank you!



Gone but never forgotten



Acute Renal Support in the ICU



CRRT

- Cardiovascular instability (cardiogenic shock, septic shock, acute liver failure)
- Metabolic acidosis
- Volume control
- Cerebral edema

IHD/PIRRT

- Hyperkalemia
- Profound acidosis
- Drug poisonings
- Anticoagulation issues with CRRT

Summary

- System-wide RRT surge plan is *required*
- System-wide expertise will be needed to operationalize & implement any RRT surge plan
 - MDs, APPs
 - RNs & staff
 - Educators
 - Administrative leadership
 - Administrative expertise
 - Supply Chain Management

ACUTE RRT IS A TEAM SPORT



RRT Surge Plan

[Nature Reviews Nephrology](#) volume 16, 747–764 (2020)

Goal:

- Use multiple methods of RRT to **maximize** # of patients who can receive appropriate RRT to meet their individual support needs.
- Equitable distribution and utilization of RRT resources to provide benefit to the most patients.

Challenge:

- Develop resource distribution systems to meet this goal.
 - Staffing
 - Supply chains
 - Machine use → when machines are limited, system to minimize machine down-time

